ATMOSPHERIC MODELING RESEARCH AND CAPABILITIES

DRI
Desert Research Institute

CAPABILITIES

- Computational Fluid Dynamics (CFD) Models
- Stochastic and HYSPLIT Trajectory Models
- Weather Research and Forecasting (WRF) Models
- CALMET and CALPUFF Modeling Systems
- Regional Air Quality Models (CMAQ and CAMx)
- Air Emissions Processing Models (BEIS, MEGAN, SMOKE)
- Global Climate System Models

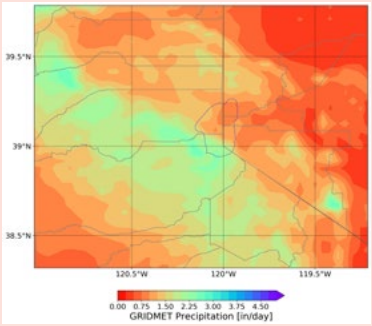
THE DRI ATMOSPHERIC MODELING GROUP implements a full suite of numerical models of the atmosphere and climate including fine-scale computational fluid dynamics codes, Lagrangian particle models, chemical transport models, medium-resolution regional weather and climate models, and fully coupled ocean-atmospheric global climate system models. DAS faculty conduct basic and applied research related to fundamental weather and climate processes, weather predictability and operational forecasting for lead-times from hours to seasonal, regional hydroclimate, air-quality modeling and forecasting, dust modeling, and renewable energy applications. DAS researchers maintain the expertise and cyberinfrastructure capabilities to perform real-time numerical weather prediction and exploratory diagnostic studies utilizing both in-house high-performance computing infrastructure and cloud-based off-site computing resources.

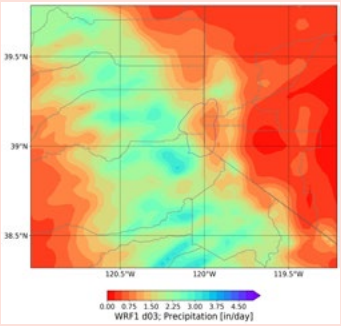
DRI'S ATMOSPHERIC MODELING FACULTY AND STAFF HAVE EXPERIENCE WITH THE FOLLOWING MODELING TOOLS:

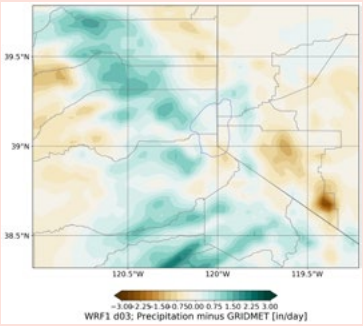
- **CMAQ and CAMx:** *Three-dimensional urban- and regional-scale multi-pollutant photochemical grid models.*
- **Stochastic Trajectory model:** *A highly adaptable dispersion Lagrangian model for backward and forward trajectories of particles for adaptation and mitigation and feasibility studies.*
- **HYSPLIT Trajectory Model:** *Lagrangian model available from NOAA Air Resources Laboratory used to compute air parcel trajectories and dispersion of atmospheric pollutants.*
- **SMOKE Emissions Model:** *The SMOKE Modeling System from EPA is used to process emissions from different anthropogenic sources. Also, BEIS and MEGAN software can be used to process emissions from biogenic sources.*
- **CALMET and CALPUFF:** *Diagnostic meteorology and dispersion models for short- and long-range transport assessments.*
- **CFD Models:** *High-resolution simulations of turbulent flows for fine-scale analyses. The openFOAM framework allows for traditional aerodynamics applications and the coupling of additional physics, such as multiphase flows, porous objects, and particle transport.*
- **WRF Model:** *Diagnostic and forecast model to develop meteorological solutions from sub-kilometer to regional scales, from case studies to intra-seasonal to decadal regional climate trends and variability. WRF is used as a basic research tool and for atmospheric applications, including operational forecasting.*
- **Global Climate System Models:** *Implementation and development of the Climate Earth System model (CESM) for process-based understanding, climate engineering, and climate change and variability impact assessments.*

EXAMPLES OF CASE STUDIES:

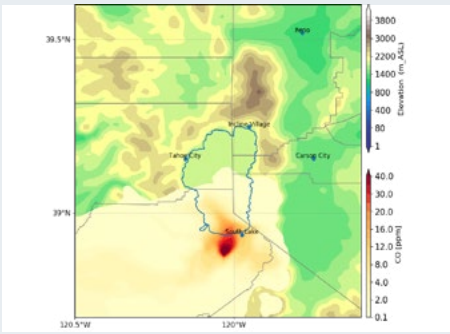
A WRF Application: *Observed and WRF simulation of a precipitating atmospheric river impacting the northern Sierra Nevada mountains.*



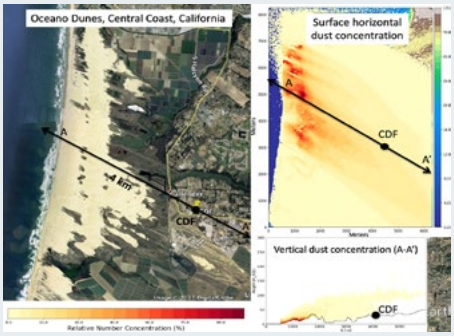




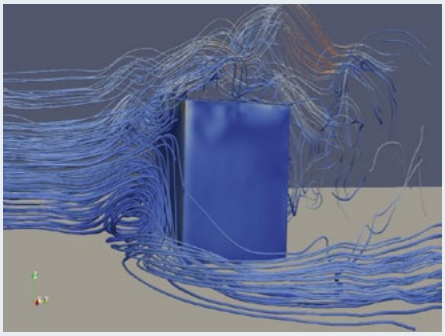
The Lake Tahoe Air Quality Modeling Study: *Carbon monoxide dispersion for a fire event near South Lake Tahoe. Model framework uses fire emissions, WRF, SMOKE and CMAQ to assess the impact of fires (real-time or simulated) to the air quality of the region.*



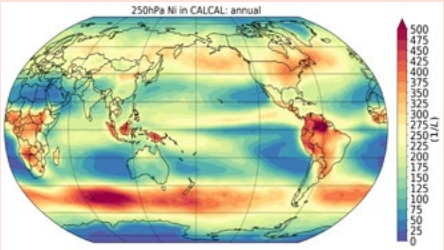
Dust Modeling Case Study: *Using the Stochastic Trajectory model to estimate dispersion of fugitive PM10 dust particles from the Oceano Dunes in Central California coast.*

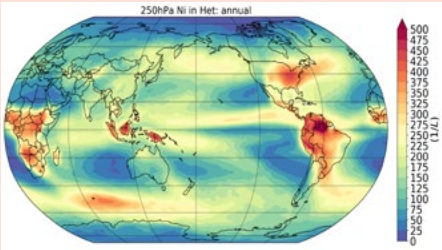


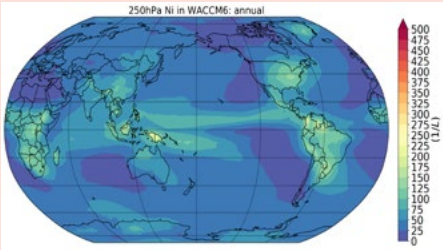
CFD Modeling Case Study: *Streamlines of flow encountering an erosion control bluff body. Arrays of bluff bodies are placed to control emissions from erosive surfaces. Simulations are used to understand the mechanism of action, and calculate the momentum extracted from the atmospheric boundary layer.*



Global Climate Models Case Study: *40 year mean of cirrus ice cloud number concentration for satellite assimilated ice diameter-temperature distribution from CALIPSO satellite (top), assuming ice formation follows heterogenous ice nucleation and CESM-WACCM baseline model. Figure highlights GCM model uncertainties in ice cloud parameterization.*







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